ONCE-THROUGH COOLING & ENERGY

1. How Critical Are the Coastal Once-Through Cooled (OTC) Plants to the State's Energy Supply?

The steam boiler plants have low usage rates and contribute only 5% of California's electricity needs. Combined, the 17 coastal plants using OTC in California have a capacity of approximately 21,000 MW.[1] Of this 21,000 MW capacity total, approximately 15,000 MW is natural gas-fired steam boiler plants, 1,600 MW are natural gas combined cycle plants, and 4,400 MW are nuclear plants.[2] The steam boiler plants are old and inefficient and have very low usage rates as a result, averaging under 10 percent in 2006.[3] The power production from the coastal steam boiler plants provided less than 5% of California's power usage in 2006.[4]

The two nuclear plants are used extensively. In contrast, two nuclear plants, Diablo Canyon and San Onofre Nuclear Generating Station (SONGS) with a combined capacity of approximately 4,400 MW, operated at an average capacity of 80 to 90 percent capacity in the 2004 to 2006 period.[5] The two nuclear plants each use 2.5 billion gallons per day of seawater.[6] These two nuclear plants account for nearly two-thirds of the OTC water utilized by the state's combined population of coastal nuclear and natural gas-fired plants.

2. Aren't the Coastal Steam Plants Needed in the Summer When Power Demand Is Highest?

Only a few of the coastal plants were considered as essential by CAISO in 2007 to ensure grid reliability. These plants are Encina and South Bay in San Diego County, Potrero and Contra Costa Units 4 & 5 in the Bay Area, and Humboldt in Northern California.[7] California generation capacity has increased by 7,000 MW since 2001, with another 2,300 MW under construction, reducing the need for the coastal steam boilers.[8] As a result of new power plant construction and transmission upgrades, California is experiencing historically high power supply reserve margins.[9] Also, California's utilities are now subject to aggressive new energy efficiency and demand response requirements that are intended to result in flat or declining peak demand over the next decade.[10]

3. Does California Have a Commitment to Modernizing the Coastal Steam Plants?

Yes. All coastal steam boiler plants identified by CAISO as essential for reliability in 2007 are already slated for replacement. An air-cooled combined cycle replacement project is proposed at Encina, and an air-cooled combined cycle plant (Otay Mesa) will begin operation near South Bay in 2009. PG&E is constructing an air-cooled combined cycle plant at its Contra Costa plant. The Humboldt plant is being replaced with an internal combustion engine powerplant that does not use water for cooling. The Potrero project is being replaced with the San Francisco Electric Reliability Project, using combustion turbines that do not require cooling water. In addition, approximately 3,000 MW of new combined cycle replacement projects have been permitted at coastal steam boiler plants.[11] Most of these projects have been proposed with air cooling.

4. Will Eliminating OTC Add to the Cost of New Coastal Plants?

Not significantly. The cooling system is a small part of the overall cost of a high efficiency, state-of-the-art combined cycle power plant. There is very little difference in the cost of a new combined-cycle plant whether it incorporates OTC, closed-cycle wet cooling, or dry cooling.[12] Most recent combined-cycle replacement projects at OTC steam boiler sites have been proposed with air cooling.[13]

5. Will Controversy Over Availability of Emission Offset Credits Prevent Cooling Tower Retrofits?

No. An existing OTC steam boiler plant that is simply going to continue operating in its current mode while converting from OTC to a cooling tower will not require emission credits. Cooling towers are exempt from South Coast Air Quality Management District (SCAQMD) permit requirements and air emission offset requirements.[14] This means that any OTC coastal plant in the SCAQMD could convert to cooling towers without a need to obtain emission offset credits. Also, there are no coastal plants in the SCAQMD identified by the CAISO as critical "must run" plants for grid reliability purposes.[15] This means that any of the OTC coastal plants located in the Los Angeles Basin that choose not to retrofit to cooling towers could be permanently shut down without compromising grid reliability.

6. Will Retrofitting to Wet Towers Jeopardize the Reliability of the State's Electrical Grid?

No. Both nuclear and steam plants have been cost-effectively and efficiently retrofit to closed-cycle wet cooling in the United States.[16,17] These retrofitted plants have proven to be completely reliable. Retrofits more costly and complex than a cooling tower retrofit are already being conducted at California's two nuclear plants.[18]

7. Is Space Available at the Coastal Plants for Cooling Towers?

Yes. A February 2008 TetraTech study prepared for the California Ocean Protection Council on the feasibility and cost of cooling tower retrofits at each of California's OTC power plant sites, including the Diablo Canyon and SONGS nuclear plants, found that space is available for cooling tower retrofits at all of these sites.

8. *Will the Retrofits Cause a Drop in Plant Efficiency?*

A very small amount, less than 1% for combined cycle plants and less than 2% for steam boilers and nuclear plants. The overall energy penalty of a steam boiler plant or nuclear plant wet cooling tower retrofit is less than 2%, not 8% as implied by CCEEB in its March 24, 2006 letter to SLC.[19,20,21,22] The energy penalty for a combined cycle plant retrofit is less than 1%.[23,24]

9. How Much Would Air Emissions Increase if the Two Nuclear Plants Are Retrofitted to Wet Towers?

A very small to insignificant amount. Output would be reduced about 1 to 2%, or 20 to 40 MW, as a result of the conversion to cooling towers. If this 20 to 40 MW is generated by a natural gas fired combined-cycle plant, the annual NO_x and PM_{10} emissions from this output would be about 9 tons/year (0.05 tons/day) and 5 tons/year (0.03 tons/day), respectively.[25,26,27] California is now aggressively developing renewable energy sources to meet state mandates. There would be no increase in air emissions if this 20 to 40 MW of power is replaced by renewable geothermal, solar, or wind resources.

10. How Much Will It Cost to Retrofit the Coastal OTC Plants?

Relatively little, as only a few plants are likely to be affected. As noted, the CAISO considered only a handful of coastal plants as critical to grid reliability and all of these plants are in the process of modernizing with state-of-the-art power generation technologies that will not require cooling water. Coastal steam boiler plants that are not considered essential for grid reliability will have to modernize to compete in a competitive power market or shut down. The modernization of these steam boiler plants is not necessary for grid reliability, will be a business decision by the owners, and will not be paid for by California ratepayers.

11. How Will the Cost of the Retrofits Affect the Cost to Generate Power?

It will have little impact. The addition of 7,000 MW of new generation capacity in California in the last several years, combined with transmission upgrades, have made the state less dependent on non-nuclear coastal plants for power.[28] The April 2008 ICF Jones & Stokes reliability study indicates that for as little as $135 million the grid can be upgraded sufficiently to assure reliable power even if all the OTC coastal steam boiler and combined cycle plants are permanently shut down.[29] The cooling tower retrofits would have very little impact on the cost of power generation from the two nuclear plants, on the order of a 2% increase.[30]

12. What Will Be the Source of Water for the Cooling Towers?

Recycled water is preferred for use in the wet towers. However, seawater is a viable option and is used in cooling towers at numerous large nuclear and steam plants in the United States. Use of seawater in closed-cycle cooling towers at either San Onofre or Diablo Canyon would reduce seawater usage by 96 percent or more.[31] Seawater may also be used to augment recycled water supplies if these supplies are not sufficient.

13. Will the Cooling Towers Emit Visible Plumes?

Not cooling towers located in populated areas. Wet towers can be equipped with plume abatement technology to minimize or eliminate vapor plumes. This is now standard practice in California for power plant cooling towers in urban areas. The February 2008 TetraTech study properly assumed that the cooling towers at SONGS would be equipped with plume-abatement technology as SONGS is located along a major interstate highway and near a city (San Clemente). In contrast, TetraTech assumed that the Diablo Canyon cooling towers would not be equipped with plume-abatement technology as the plant is located in a completely isolated location.

14. Will the Cooling Towers Emit Particulates?

Yes, some particulate (salt drift) emissions would be generated by the cooling tower. Advanced "drift" eliminators are incorporated into cooling towers to minimize this water droplet carryover. Cooling towers using recycled water account for only a small amount of overall power plant PM_{10} emissions. An industry survey of operators of seawater cooling towers notes these operators have not reported any problems associated with salt drift at their facilities.[32] Cooling towers using reclaimed water would produce considerably less particulate emissions due to the much lower dissolved solids content compared to seawater.

15. How Are Other States and Regions Addressing OTC Plants?

Other states and regions are aggressively pursuing wet tower retrofits. EPA Region 1 (New England) has required the retrofit of a 1,600 MW coal plant (Brayton Point Station, Massachusetts) to wet towers.[33] New York Department of Environmental Conservation (NYDEC) has recommended that the 2,000 MW Indian Point nuclear plant be retrofitted to wet towers. NYDEC determined that a wet tower cost impact of less than 6 percent of revenue was not an unreasonable financial burden on the owner.[34]

[1] ICF Jones & Stokes, *Electric Grid Reliability Impacts from Regulation of Once-Through Cooling in California*, prepared for California Ocean Protection Council, April 2008, Table 3-1, p. 19.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid, Table 3-1, p. 19.

[6] CEC, *Issues And Environmental Impacts Associated with Once-Through Cooling at California's Coastal Power Plants*, CEC-700-2005-013, June 2005, p. 12, Figure 1.

[7] Ibid, p. 12.

[8] Ibid, p. 21.

[9] ICF Jones & Stokes, *Electric Grid Reliability Impacts from Regulation of Once-Through Cooling in California*, prepared for California Ocean Protection Council, April 2008, pp. 21-25.

[10] Powers Engineering, comment letter on (CEC) Renewable Energy Transmission Initiative Phase 1B draft report, November 19, 2008, pp. 9-10. See: http://www.energy.ca.gov/reti/documents/phase1B/comments/2008-11-20_Powers_Engineering.pdf

[11] Ibid, Table 1-1, p. 9.

[12] John Maulbetsch, PhD presentation on cost of cooling technologies to the State Water Resources Control Board on behalf of California Energy Commission, December 7, 2005.

[13] These air cooled combined cycle replacement projects include Carlsbad Energy Center (Encina), Gateway Energy Center (Contra Costa), and the South Bay Replacement Project (withdrawn).

[14] SCAQMD Rule 219, *Equipment Not Requiring a Written Permit*, (d)(3) –cooling towers.

[15] ICF Jones & Stokes, *Electric Grid Reliability Impacts from Regulation of Once-Through Cooling in California*, prepared for California Ocean Protection Council, April 2008, p. 12.

[16] Retrofitting to a wet tower is fundamentally simple - the OTC pipes going to and from the ocean are rerouted to a cooling tower. At facilities that have been retrofit, the hook-up of the new cooling system has generally been carried-out without requiring an extended unscheduled outage. The cost to retrofit 800 MW Palisades Nuclear (MI) to wet towers was $68/kW (1999 dollars). The cost to retrofit 750 MW Pittsburg Unit 7 (CA) was $46/kW (1999 dollars) [ref: EPA 316(b) Phase II Technical Development Document, Chapter 4].

[17] TetraTech, *California's Coastal Power Plants: Alternative Cooling System Analysis*, prepared for California Ocean Protection Council, February 2008, Chapter 7. Average estimated cost of a cooling tower retrofit for the two OTC combined cycle plants (Moss Landing and Haynes) is $70 to $75/kW. Estimated cost of a cooling tower retrofit for a typical OTC steam boiler plant (Huntington Beach Generating Station) is $150/kW.

[18] 2,160 MW Diablo Canyon was recently authorized by the CPUC to replacing aging steam generators at a cost of $700 million [ref: California Energy Circuit, *CPUC Approves $706 million for Diablo Canyon*, February 25, 2005, p. 1]. A steam turbine replacement project authorized by the CPUC for 2,200 MW San Onofre is estimated to cost $680 million [ref: CPUC San Onofre Steam Generator Replacement Proceeding, Decision 05-12-040 December 15, 2005] These steam generator retrofits will cost in the range of $320/kW to $330/kW, higher than the probable cost to retrofit these plants to wet towers.

[19] EPA 316(b) Phase II Technical Development Document, Chapter 5, Sections 5.6.1 through 5.6.3, p. 5-34. The measured annual efficiency penalty at 346 MW Jeffries Station is 0.16%. The cooling tower pump and fan energy demand for steam plants is estimated by EPA at 0.73%. Total energy penalty for Jeffries Stations would be approximately 0.9%.

[20] Rebuttal testimony of William Powers, P.E., DEC # 3-3346-00011/00002, In Matter of Renewal of State Pollutant Discharge Elimination System ("SPDES") permit SPDES # NY-0006262 for 500 MW Danskammer Power Plant, November 7, 2005. Annual energy penalty following retrofit of 235 MW Unit 4 at Danskammer to closed-cycle wet cooling (cooling tower) calculated at 0.6% using site-specific historical Unit 4 OTC performance data and local meteorological data.

[21] March 24, 2006 California Council for Economic and Environmental Balance (CCEEB) letter to Paul Thayer, Executive Director, State Lands Commission. CCEEB states that retrofitting air cooling to 20,759 MW of existing coastal boilers would impose a 1,724 MW energy penalty during critical peak demand periods. This equals an energy penalty of 1,724/20,759 = 8.3%.

[22] EPA 316(b) Phase II Technical Development Document, Chapter 5, Table 5-2, p. 5-2. Summer peak steam boiler efficiency penalty is 1.7%.

[23] Ibid. Summer peak combined cycle efficiency penalty is 0.4%.

[24] TetraTech, *California's Coastal Power Plants: Alternative Cooling System Analysis*, prepared for California Ocean Protection Council, February 2008, Chapter 7, p. F30-F31, p. J29-J30.

[25] CARB, Guidance for the Permitting of Electric Generation Technologies, Stationary Source Division, July 2002, p. 9 (NO_x emission factor = 0.07 lb/M-hr combined-cycle plants)

[26] San Diego County Air Pollution Control District (APCD), Otay Mesa Power Project (air-cooled), Authority To Construct 973881, 18 lb/hr particulate without duct firing (510 MW output), equals ~ 0.04 lb/MW-hr.

[27] San Onofre is located in San Diego County. The NO_x and PM_{10} emissions offset thresholds defined by San Diego County APCD Rule 20.1 ("New Source Review General Provisions") are 50 tons/year for NO_x and 100 tpy for PM_{10}. Diablo Canyon is located in San Luis Obispo County. The NO_x and PM_{10} emissions offset thresholds defined by San Luis Obispo APCD Rule 204 ("Requirements") are 25 tons/year for NO_x and 25 tpy for PM_{10}.

[28] ICF Jones & Stokes, *Electric Grid Reliability Impacts from Regulation of Once-Through Cooling in California*, prepared for California Ocean Protection Council, April 2008, pp. 21-23.

[29] Ibid, p. 3. "The less severe case of all OTC plants except the nuclear units retiring in 2015 showed that the retirements could be compensated for with as little as $135 million in in-state transmission system upgrades."

[30] Powers Engineering, *Converting California's Two Nuclear Plants to Cooling Towers – Fact Sheet*, prepared for California Coastkeeper Alliance, January 22, 2009.

[31] TetraTech, *California's Coastal Power Plants: Alternative Cooling System Analysis*, prepared for California Ocean Protection Council, February 2008, Chapter 7, C-1.

[32] Dr. Shahriar Eftekharzadeh – Bechtel, *Feasibility of Seawater Cooling Towers for Large-Scale Petrochemical Development*, Cooling Technology Institute Journal, Summer 2003, Vol. 24 No. 2, pp. 50-64. Operators of seawater cooling towers have not reported any problems associated with salt drift at their facilities. Site inspections of two long-time saltwater cooling tower installations did not exhibit any visible signs of salts fallout.

[33] See: http://www.epa.gov/region01/braytonpoint/

[34] New York Department of Environmental Conservation, *Fact Sheet - New York State Pollutant Discharge Elimination System (SPDES) Draft Permit Renewal With Modification,* Indian Point Electric Generating Station, Buchanan, NY - November 2003.